

**What is claimed is:**

**[Claim 1]** A variable phase shifter module, comprising:

a first main PCB having an input trace coupled to a first wiper junction; a first arcuate trace extending between a first output trace and a second output trace on the first main PCB, the first arcuate trace having an arc center proximate the first wiper junction; and

a first wiper PCB having a linking trace thereon; the wiper PCB rotatably coupled to the first main PCB proximate the first wiper junction with the linking trace facing the first main PCB;

the linking trace coupling the first wiper junction with the first arcuate trace.

**[Claim 2]** The apparatus of claim 1, further including a second arcuate trace extending between a third output trace and a fourth output trace; the second arcuate trace having an arc center proximate the first wiper junction.

**[Claim 3]** The apparatus of claim 1, further including a fifth output trace coupled to the first wiper junction.

**[Claim 4]** The apparatus of claim 1, further including an arcuate edge guide surface formed in the first main PCB having an arc center proximate the first wiper junction; and a clip coupled to the wiper to bias the first wiper PCB against the first main PCB, about the arcuate edge guide surface.

**[Claim 5]** The apparatus of claim 1, further including an arcuate guide slot formed in the first main PCB having an arc center proximate the first wiper junction; and a fastener extending through the guide slot and a guide hole formed in the first wiper PCB to bias the wiper against the first main PCB.

**[Claim 6]** The apparatus of claim 1, wherein the first output trace and second output trace have a width and length adapted for a desired power division and pre-set phase shift differential.

**[Claim 7]** The apparatus of claim 1, wherein one of the first main PCB, the first wiper PCB and both of the first main PCB and the first wiper PCB have a dielectric coating.

**[Claim 8]** The apparatus of claim 1, further including a second main PCB with a second wiper PCB coupled proximate a second wiper junction; the wiper rotatably coupled to the second printed circuit board proximate the second wiper junction; the first wiper junction and the second wiper junction aligned in a spaced apart coaxial orientation.

**[Claim 9]** The apparatus of claim 8, wherein the first wiper PCB and the second wiper PCB are coupled together, commonly movable via a linkage arrangement.

**[Claim 10]** The apparatus of claim 9, wherein the linkage arrangement is a linkage pin joining the first clip to the second clip, the linkage pin passing through a linkage slot formed in a linkage plate of a linkage arm.

**[Claim 11]** The apparatus of claim 8, further including a base plate to which the first PCB and second PCB are coupled; a trace side of the first PCB and of the second PCB each facing the baseplate.

**[Claim 12]** The apparatus of claim 8, further including a base plate to which the first PCB and second PCB are coupled; a trace side of the first PCB and of the second PCB arranged facing away from each other.

**[Claim 13]** The apparatus of claim 8, further including an arcuate edge guide surface formed in the first main PCB having an arc center proximate the first wiper junction; and a clip coupled to the wiper to bias the wiper against the first main PCB, about the arcuate edge guide surface.

**[Claim 14]** The apparatus of claim 1, wherein the wiper PCB has an epoxy glass substrate.

**[Claim 15]** The apparatus of claim 1, wherein the wiper PCB has a linkage slot formed in a distal end.

**[Claim 16]** A variable phase shifter module, comprising:

a first main PCB having an input trace coupled to a first wiper junction; a first arcuate trace extending between a first output trace and a second output trace on the first main PCB, the first arcuate trace having an arc center proximate the first wiper junction; a second arcuate trace extending between a third output trace and a fourth output trace; the second arcuate trace having an arc center proximate the first wiper junction; a first wiper PCB having a linking trace thereon; the wiper PCB rotatably coupled to the first main PCB proximate the first wiper junction with the linking trace facing the first main PCB; and an arcuate edge guide surface formed in the first main PCB having an arc center proximate the first wiper junction; and a clip coupled to the wiper to bias the first wiper PCB against the first main PCB, about the arcuate edge guide surface; the linking trace coupling the first wiper junction with the first arcuate trace and the second arcuate trace.

**[Claim 17]** The apparatus of claim 16, further including a second main PCB with a second wiper PCB coupled proximate a second wiper junction; the wiper rotatably coupled to the second printed circuit board proximate the second wiper junction; the first wiper PCB and the second wiper PCB coupled together; the first wiper junction and the second wiper junction aligned in a spaced apart coaxial orientation.

**[Claim 18]** The apparatus of claim 17, further including a base plate to which the first PCB and second PCB are coupled; a trace side of the first PCB and of the second PCB each facing the baseplate.

**[Claim 19]** The apparatus of claim 17, further including a base plate to which the first PCB and second PCB are coupled; a trace side of the first PCB and of the second PCB arranged facing away from each other.

**[Claim 20]** The apparatus of claim 16, further including a linkage slot formed in the distal end of the first wiper PCB.

**[Claim 21]** A low-height panel antenna comprising:  
an array of radiating elements;  
a feed network connecting a signal input to said array of radiating elements;  
and  
a phase shifter assembly located in said feed network and configured to adjust the phasing of signals fed to said array of radiating elements, said phase shifter assembly comprising a moveable conductive component coupled to the input and capacitively coupled to a transmission line segment of the network between radiating elements, the wiper conductive component or transmission line segment having a dielectric coating providing dielectric separation of the transmission line segment and the wiper conductive component.

**[Claim 22]** The antenna of claim 21 wherein said moveable conductive component comprises a conductive trace on a PC board wiper body, the trace being located on the side of the wiper body facing the transmission line segment.

**[Claim 23]** The antenna of claim 22 wherein said transmission line segment is configured as a segment of a circle and wherein said wiper body is pivoted at the center of the circle.

**[Claim 24]** The antenna of claim 22 wherein said wiper body includes an extension adapted for coupling to a phase shifter adjustment linkage.

**[Claim 25]** The antenna of claim 21 wherein said dielectric coating is composed of soldermask or an organic compound.

**[Claim 26]** A low-height phase shifter assembly adapted to adjust the phasing of signals fed through a transmission line network to an array of antenna radiating elements, said phase shifter assembly having a moveable wiper comprising a dielectric substrate with a conductive layer on a surface of the substrate facing and spaced from a segment of the transmission line.

**[Claim 27]** The phase shifter assembly of claim 26 wherein said dielectric substrate comprises a PC board and said conductive layer is a trace formed on the said surface of the PC board.

**[Claim 28]** The phase shifter assembly of claim 27 wherein said trace has a coating composed of dielectric material.

**[Claim 29]** The phase shifter assembly of claim 28 wherein said dielectric coating comprises soldermask or organic material.

**[Claim 30]** The phase shifter assembly of claim 26 wherein said dielectric substrate is configured to be coupled to a phase shifter adjustment linkage.

**[Claim 31]** A low-height panel antenna comprising:  
an array of radiating elements;  
a feed network connecting a signal input to said array of radiating elements;  
and  
a low-height phase shifter assembly as described in claim 200 located in said feed network and configured to adjust the phasing of signals fed to said array of radiating elements.

**[Claim 32]** The panel antenna of claim 31 including a predetermined plurality of arrays of radiating elements, and a corresponding plurality of said phase shifter assemblies arranged in a stack to control signal phasing in said plurality of arrays of radiating elements.

**[Claim 33]** The panel antenna of claim 31 having a coupling arrangement configured to couple said plurality of phase shifter assemblies together and to a phase shifter adjustment linkage such that movement of the linkage moves said plurality of phase shifter assemblies together as one unit.

**[Claim 34]** A low-height phase shifter assembly adapted to adjust the phasing of signals fed through a transmission line network to an array of antenna radiating elements, said phase shifter assembly comprising a moveable conductive component coupled to a signal input and capacitively coupled to a segment of the transmission line network between radiating

elements, the wiper conductive component or transmission line segment having a dielectric coating providing dielectric separation of the transmission line segment and the wiper conductive component.

**[Claim 35]** The phase shifter assembly of claim 34 wherein said moveable conductive component comprises a conductive trace on a PC board wiper body, the trace being located on the side of the wiper body facing the transmission line segment.

**[Claim 36]** The phase shifter assembly of claim 35 wherein said transmission line segment is configured as a segment of a circle and wherein said wiper body is pivoted at the center of the circle.

**[Claim 37]** The phase shifter assembly of claim 35 wherein said wiper body includes an extension adapted for coupling to a phase shifter adjustment linkage.

**[Claim 38]** 37. The phase shifter assembly of claim 34 wherein said dielectric coating is composed of soldermask or organic material.

**[Claim 39]** A low-height panel antenna comprising:  
an array of radiating elements;  
a feed network connecting a signal input to said array of radiating elements;  
and  
a low-height phase shifter assembly as described in claim 300 located in said feed network and configured to adjust the phasing of signals fed to said array of radiating elements.

**[Claim 40]** The panel antenna of claim 39 including a predetermined plurality of arrays of radiating elements, and a corresponding plurality of said

phase shifter assemblies arranged in a stack to control signal phasing in said plurality of arrays of radiating elements.

**[Claim 41]** The panel antenna of claim 39 having a coupling arrangement configured to couple said plurality of phase shifter assemblies together and to a phase shifter adjustment linkage such that movement of the linkage moves said plurality of phase shifter assemblies together as one unit.